Electronic Version
Stylesheet Version v1.1.1

Claims

[c1] What is claimed is:

1. A light emitting diode (LED) comprising:

a substrate;

a light emitting stacked structure formed over the substrate;

a dual dopant contact layer formed over the light emitting stacked structure, the dual dopant contact layer comprising a plurality of p-type dopants and a plurality of n-type dopants; and

a transparent conductive oxide layer formed over the dual dopant contact layer.

[c2] 2. The LED of claim 1, wherein the dual dopant contact layer is made of AlInGaN-based material, the transparent conductive oxide layer is made of Indium-tin oxide (ITO), Cadmium-tin oxide, Antimony-tin oxide (ATO), Zinc oxide (ZnO), or Zinc-tin oxide.

[c3] 3. The LED of claim 1, wherein the dual dopant contact layer is formed by adding the p-type dopants and the n-type dopants together through an epitaxy growth.

[c4] 4. The LED of claim 1, wherein the dual dopant contact

layer is formed through a cooling rate less than 40°C/min.

[c5] 5. A light emitting diode (LED) comprising:
an insulating substrate;
a buffer layer formed over the insulating substrate;
a first conductivity type contact layer formed over the buffer layer, the first conductivity type contact layer comprising a first upper surface and a second upper surface;
a multiple quantum well light emitting layer formed over the first upper surface;
a second conductivity type contact layer formed over the multiple quantum well light emitting layer;
a dual dopant contact layer formed over the second conductivity type contact layer, the dual dopant contact layer comprising a plurality of p-type dopants and a plurality of n-type dopants;
a transparent conductive oxide layer formed over the dual dopant contact layer;
a second conductivity type electrode formed over the transparent conductive oxide layer; and
a first conductivity type electrode formed over the second upper surface.

[c6] 6. The LED of claim 5, wherein the insulating substrate is made of sapphire, $LiGaO_2$, or $LiAlO_2$; the buffer layer is

made of AlInGaN-based material or II-nitride-based material; the second conductivity type contact layer is made of GaN, AlGaN, or InGaN; the first conductivity type contact layer is made of GaN, AlGaN, or InGaN; the transparent conductive oxide layer is made of Indium-tin oxide (ITO), Cadmium-tin oxide, Antimony-tin oxide (ATO), Zinc oxide (ZnO), or Zinc-tin oxide;the dual dopant contact layer is made of AlInGaN-based material; the n-type dopants are made of Si, Ge, Sn, Te, O, S, or C; and the p-type dopants are made of Mg, Zn, Be, or Ca.

[c7] 7. The LED of claim 5, wherein the multiple quantum well has r InGaN quantum wells and (r+1) InGaN barriers, each InGaN quantum well is sandwiched in between two InGaN barriers, each InGaN quantum well is fabricated by $In_eGa_{1-e}N$, and each InGaN barrier is made of $In_fGa_{1-f}N$, $r \geq 1$, and $0 \leq f < e \leq 1$.

[c8] 8. The LED of claim 5 further comprising a first conductivity type cladding layer interposed between the first conductivity type contact layer and the multiple quantum well light emitting layer and the first conductivity type cladding layer is made of $Al_xGa_{1-x}N$, and $0 \leq x \leq 1$.

[c9] 9. The LED of claim 5 further comprising a second conductivity type cladding layer interposed between the second conductivity type contact layer and the multiple

quantum well light emitting layer and the second conductivity type cladding layer is made of $Al_zGa_{1-z}N$, and $0 \leq z \leq 1$.

[c10] 10. The LED of claim 5, wherein the dual dopant contact layer is formed by adding the p-type dopants and the n-type dopants together through an epitaxy growth.

[c11] 11. The LED of claim 5 wherein the dual dopant contact layer is formed through a cooling rate less than 40°C/min.

[c12] 12. A light emitting device (LED) comprising:
a first conductivity type electrode;
a first conductivity type conductive substrate formed over the first conductivity type electrode;
a buffer layer formed over the first conductivity type conductive substrate;
a first conductivity type contact layer formed over the buffer layer;
a multiple quantum well light emitting layer formed over the first conductivity type contact layer;
a second conductivity type contact layer formed over the multiple quantum well light emitting layer;
a dual dopant contact layer formed over the second conductivity type contact layer, the dual dopant contact layer comprising a plurality of p-type dopants and a plurality

of n-type dopants;

a transparent conductive oxide layer formed over the dual dopant contact layer; and

a second conductivity type electrode formed over the transparent conductive oxide layer.

[c13] 13. The LED of claim 12, wherein the first conductivity type conductive substrate is made of GaN, SiC, Si, Ge, AlN, GaAs, InP, or GaP; the buffer layer is made of AlIn-GaN-based material or II-nitride-based material; the second conductivity type contact layer is made of GaN, AlGaN, or InGaN; the first conductivity type contact layer is made of GaN, AlGaN, or InGaN; the dual dopant contact layer is made of AlInGaN-based material; the n-type dopants are made of Si, Ge, Sn, Te, O, S, or C; the p-type dopants are made of Mg, Zn, Be, or Ca; and the transparent conductive oxide layer is made of Indium-tin oxide (ITO), Cadmium-tin oxide, Antimony-tin oxide (ATO), Zinc oxide (ZnO), or Zinc-tin oxide.

[c14] 14. The LED of claim 12, wherein the multiple quantum well has r InGaN quantum wells and (r+1) InGaN barriers, each InGaN quantum well is sandwiched in between two InGaN barriers, each InGaN quantum well is made of $In_eGa_{1-e}N$, and each InGaN barrier is made of $In_fGa_{1-f}N$, $r \geq 1$, and $0 \leq f < e \leq 1$.

[c15] 15. The LED of claim 12 further comprising a first conductivity type cladding layer interposed between the first conductivity type contact layer and the multiple quantum well light emitting layer and the first conductivity type cladding layer is made of $Al_xGa_{1-x}N$, and $0 \leq x \leq 1$.

[c16] 16. The LED of claim 12 further comprising a second conductivity type cladding layer interposed between the second conductivity type contact layer and the multiple quantum well light emitting layer and the second conductivity type cladding layer is made of $Al_zGa_{1-z}N$, wherein $0 \leq z \leq 1$.

[c17] 17. The LED of claim 12, wherein the dual dopant contact layer is formed by adding the p-type dopants and the n-type dopants together through an epitaxy growth.

[c18] 18. The LED of claim 12, wherein the dual dopant contact layer is formed through a cooling rate less than 40°C/min.